CLAIMS

We claim:

1. A metallic glass alloy of the formula $X_aCu_bNi_cAl_dY_e$ wherein

X comprises at least one element from Group IVA;

Y comprises at least one element from Group VA, VIII, IVB, VB, or Group IVA, wherein X is not equal to Y;

a is less than 45 atomic percent;

b is from about 15 to about 35 atomic percent;

c is from about 5 to about 25 atomic percent;

d is from about 0.1 to about 20 atomic percent; and

e is from about 0.1 to about 15 atomic percent, wherein a+b+c+d+e=100.

2. The metallic glass alloy of claim 1, wherein a is 44.5 atomic percent or less.

3. The metallic glass alloy of claim 2, wherein X is Hf, Zr, or Sn and Y is Ti or Nb.

4. The metallic glass alloy of claim 1, further comprising a density greater than about 7 g/cm^3.

5. The metallic glass alloy of claim 4, wherein the density is about 10.5 g/cm^3 or more.

6. The metallic glass alloy of claim 1, wherein the alloy exhibits a distinct glass transition temperature, which is at least 0.59 of the liquidus temperature of the alloy.

7. The metallic glass alloy of claim 1, wherein the ratio of copper to nickel is 2:1.

8. The metallic glass alloy of claim 3, wherein the ratio of copper to nickel is 2:1.

9. The metallic glass alloy of claim 3, having about 5 or more atomic percent Ti.

10. The metallic glass alloy of claim 3, having about 5 or more atomic percent Nb.

11. The metallic glass alloy of claim 1, wherein d is about 10 or more.

12. The metallic glass alloy of claim 1, wherein $35<a<45$, $15<b<35$, $5<c<25$, $0<d<20$, and $0<e<15$.

13. An article comprising the metallic glass alloy of claim 1.

14. The article of claim 13 having a thickness of at least 1 millimeter in its smallest dimension.

15. The article of claim 13 having a thickness at least 3 millimeters in its smallest dimension.

16. A metallic glass alloy composition comprising:

44.5 atomic percent hafnium;
about 27 atomic percent copper;
about 13.5 atomic percent nickel;
about 10 atomic percent aluminum; and
about 5 atomic percent titanium or niobium.

17. The composition of claim 16 having a density greater than 7 g/cm^3.

18. The composition of claim 16, having a density of about 10.9 g/cm^3 or more.

19. The composition of claim 16, wherein the composition exhibits a distinct glass transition temperature of at least 0.59 of the liquidus temperature of the composition.

20. An article comprising the metallic glass alloy of claim 16.

21. The article of claim 20 having a thickness of at least 1 millimeter in its smallest dimension.

22. The article of claim 20 having a thickness of at least 3 millimeters in its smallest dimension.

23. The article of claim 20, wherein the ratio of copper to nickel is 2:1.

24. The article of claim 20, wherein the metallic glass is at least partially crystalline.

25. The article of claim 20, wherein the article has an elastic strain to failure between about 1.8 and 2.2 percent elongation.

26. The article of claim 20, wherein the object has a quasi-static compressive yield stress of between about 1.8 and 2.2 GPa.

27. The article of claim 20, wherein the object has a dynamic high-strain-rate yield stress of between about 1.3 and 1.6 GPa.

28. A metallic glass alloy comprising Hf, Cu, and Ni in eutectic combination with Al, Ti, Nb or a combination thereof, having a density greater than about 7 g/cm^3.

29. A method for forming a metallic glass alloy comprising:
combining 44.5 atomic percent hafnium;
about 27 atomic percent copper;
about 13.5 atomic percent nickel;
about 10 atomic percent aluminum; and
about 5 atomic percent titanium or niobium.

30. The metallic glass alloy of claim 1, wherein the alloy is formed by electric arc melting.

31. The metallic glass alloy of claim 1, wherein the alloy is formed by induction melting.

32. The article of claim 16, wherein the article is formed by vacuum suction casting.

33. The article of claim 16, wherein the article is formed by permanent mold casting, injection die casting, pour casting, planar flow casting, melt spinning, or extrusion.

34. A method for making an alloy, comprising:

eutectically combining Hf, Cu, and Ni with Al, Ti, Nb or a combination thereof, to form a metallic glass alloy having a density greater than about 7 g/cm^3.